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CURRENT ACTIVITIES

PRAIRIE PROVINCES

Aphids of the Genus Cinara Curtis in Canada.—Seven species, which apparently have not previously been found in Canada, have recently been identified and added to the reference collection. These species, and the host trees they were collected from, are as follows:

Species	Host Tree
Cinara braggii (Gillette)	*Picea glauca*
" *ferrisi* (Swain)	*Pinus monticola*
" *occidentalis* (Davidson)	*Abies grandis*
" *oregonensis* (Wilson)	*Pinus contorta* var. *latifolia*
" *pinivora* (Wilson)	*Pinus banksiana*
" *sabinae* (Gillette and Palmer)	*Juniperus scopulorum*
" *vandykei* (Wilson)	*Picea engelmannii*

The various species of *Cinara* were highly selective in the sites that they occupied on the host trees. Some species, such as *C. fornacula* Hottes, were always found on the small twigs or current shoots. Other species, such as *C. curvipes* (Patch), although they may begin feeding on the twigs in the early spring, occur on the larger limbs or trunks throughout most of the season. The length of the rostrum has been found to be related to the feeding site. The species in which the rostrum is short are those that are invariably found feeding on the new shoots, twigs, or small branches. Species which feed on the larger limbs or trunk have long rostrums. It is thought that this relationship between the feeding site and the length of the rostrum will prove useful in dividing the genus into groups of similar species, as the first step in devising a key to the Canadian species.—G. A. Bradley.

Effects of Trichoderma on Tree Seedlings and on their Pathogens.—Several experiments have been made by the author to explore the importance of *Trichoderma* species in relation to tree seedlings. The results are summarized here, although definite conclusions have not yet been reached. However, the tentative conclusions may be of use since it is likely that other workers are studying this interesting and common soil fungus.

Preliminary experiments performed with various Finnish tree species in quartz sand media suggested that *Trichoderma* sp. might be pathogenic to heavily shaded seedlings. This possibility was tested further by inoculating half-strength potato dextrose agar in jars with a Finnish *Trichoderma* strain, and sowing surface-sterilized seed of *Pinus banksiana* Lamb. on the colonies. In addition to this *Trichoderma* strain (F), suspected of being pathogenic, strains isolated from a seedling of *P. banksiana* in Saskatchewan (S) and from soil in Connecticut (C) were similarly tested. The jars were kept under two different light intensities at 20°C. The survival percentages were as follows:

Light, ft. c.	C	S	F	
20	41	25	11	
450	65	66	56	$LSD_{0.01} = 9$
	$LSD_{0.05} = 5$			

The results indicate that *Trichoderma* strains are potentially pathogenic, especially under weak light, and that the strains differ in their pathogenicity. These conclusions were confirmed in other tests with these and other strains and with seedlings of *P. banksiana*, *P. sylvestris* L., *Betula pubescens* Ehr., *B. lutea* Michx. f., and *Caragana arborescens* Lam. on various sterilized agar media.

To study the effects of *Trichoderma* on an important pathogen the following experiment was conducted. Potato dextrose agar plates were inoculated at one edge with a *Rhizoctonia solani* Kühn strain which has been proved strongly virulent on various tree seedlings. The opposite edge was inoculated with a strain of *Trichoderma*. Eleven strains of *Trichoderma* were used in this manner. The tests were repeated at three temperatures, 7, 15, and 25°C. All the fungi grew well at these temperatures. Every strain of *Trichoderma* reduced growth of *R. solani* antibiotically from a distance of several centimetres. When *Trichoderma* colonies contacted the *R. solani* colonies, these ceased to enlarge and were overgrown by *Trichoderma*.

As a next step, *Trichoderma* was studied in certain soils. Seedlings of *P. banksiana* were grown in pots in sterile and non-sterile garden soils and in *Sphagnum* peat. Each soil was heavily inoculated with spore suspensions of two *Trichoderma* strains. All combinations were replicated under three slightly different light conditions. No significant effects were detected. Rather than being pathogenic, *Trichoderma* appeared to increase slightly the survival of the seedlings. In another experiment *Trichoderma* strains were at first inoculated on agar in jars. Soil was then poured on top of the colonies and seeded with *P. banksiana*. This soil was sandy loam from a nursery and was known to contain both *R. solani* and *Pythium ultimum* Trow. The soil was either left in normal state (N), amended by 2/100 malt syrup (M), by 1/3 lichen powder (L), or autoclaved (A). The survival percentages in three weeks were as follows:

	N	M	L	A
Control	1	11	5	55
Trichoderma (av. of 3 strains)	1	4	6	59

Neither pathogenicity nor biological control by any of the *Trichoderma* strains could be demonstrated in this test. The results were the same when *Trichoderma* was allowed to invade the soil layer before the seeding was done. The high mortality caused by *Pythium* and *Rhizoctonia* flora in all non-autoclaved soils appeared to be slightly decreased by the soil amendments. Further tests are being made with other amendments to find if some may exert a worth-while reduction of damping-off.

These studies demonstrated potential pathogenicity and potential antagonism to other pathogens by *Trichoderma*, but cast considerable doubt on the actual importance of either action in certain soils. One explanation of this is that the fairly phytotoxic and strongly antifungal antibiotics known to be produced by *Trichoderma* may accumulate under certain conditions but not under others. For instance, they may be largely inactivated by fine particles of soil.—O. Vaartaja.

ROCKY MOUNTAIN REGION

Relationships Between Site and Decay in Subalpine Spruce in Alberta.—A systematic survey of the East Slope Region of the Canadian Rockies was made in 1953 to examine site factors in relation to root and butt infections of subalpine spruce. The following is a report on a preliminary analysis of the data.

The study was based on 53 sample plots established within the spruce type in uncut stands representing a variety of site and stand conditions. Records were made on elevation, aspect, slope, and ground cover composition, and samples were taken from the "B" horizon of the soil for laboratory determinations of total nitrogen, pH, and texture. The depth of the A_0 horizon was measured. Basal infections were determined from samples obtained with an increment borer from the base of the trees. Infection ratings for each plot were determined by calculating the ratio of infected spruce trees to the total number of living spruce trees occurring on the plots. Usually, the sample consisted of 10 spruce trees on each of the plots. For the vegetation analysis, the plot data were first separated into three distinctive geographical regions which were determined by watershed limits, and then arranged into two groups of plots representing low (0 to 20%) and excessive (40% or more) numbers of basally infected trees. The presence of specific indicator plants on the plots in each infection class was determined by using Braun-Blanquet's method for estimating the significance of plant indicators in plant associations. Depending upon the relative occurrence of low-infection and high-infection indicator plants, the plots were then separated into three site types each of which represented a natural unit of vegetation; each presumably having a similar environment.

Within each site type, the trees were arranged in age classes and the incidence of infected trees was calculated for each class. This analysis showed that the percentage of infected trees increased with increasing age of the trees at different rates for the three sites. The average infection values obtained for the three site classes were 12.1%, 22.2% and 35.1%. This appraisal led to the conclusion that the disease status of the site types could be designated I, II, and III, thus providing site indexes for stands having low, moderate, and high numbers of basally infected trees respectively. At the advanced age of 270 years, only 15% of the spruce trees that were examined on the class I sites were infected, while all the trees of this age on the class III sites possessed some basal rot. The sites also appeared to be characterized by different rates of stand deterioration as demonstrated by the different age structures in the groups. Thus, the older age classes, viz. those in excess of 150 years, contained 57% of the trees on the class I sites, 44% on the class II sites, and only 37% on the class III sites.

Differences in the vegetation occurring between the low infection and high infection sites appeared to reflect differences in the moisture conditions, since indicator plants for the low infection sites include such xerophytic plants commonly associated with dry sites in Alberta as *Juniperus canadensis, Shepherdia canadensis, Arctostaphylos uva-ursi, Fragaria glauca,* and *Pinus contorta.* On this basis class I sites with a low incidence of disease might be described as dry, and the class III sites, where hydrophytic plants dominated, as moist.

Observations also indicated the existence of a definite link between the rate of diameter growth and susceptibility to infection in the trees. There was a consistent increase in the number of infections with an increasing width of the annual rings. Using height as a criterion of growth, a similar but less pronounced trend was obtained but this might be attributed to the fact that average height values unlike the average diameter values were not based on all the spruce trees occurring on plots, but on one or two dominants.

Attention was next directed to the possibility of discovering if other criteria exist which demonstrate the ecological distinctiveness of the pathological sites. The positive or negative association of any particular site factor, e.g., high or low nitrogen content of the soil, or high or low elevation, with a particular site, was appraised by first separating the plot data into two groups, each group representing one of the two opposing effects to be tested. The data were then arranged in contingency tables under the appropriate site class designated for the plot. If a relationship was absent, the observed frequency of plots falling into a particular site class should approximate the calculated expectations, and the resulting chi square value would be small. For example, Table I shows how the frequencies for the plots from high and low elevations are distributed among the three site classes.

Initially an arbitrary altitude value defining the class limits was employed and the value which gave the best contingency chi square value was taken to represent the critical value for the maximum environmental effect of the factor on infection. In this case, an elevation of 4400 feet above sea level gave a significant chi square value ($P = .01$). The results of analysing the factors employing this method are given in Table II.

The importance of such physiographic features of sites as elevation, aspect, and slope can be seen from these data. Thus, stands of spruce which are located on a west, southwest, or south slope having a gradient in excess of 15.5% at altitudes below 4400 ft. above sea level, might be expected to support more infected trees than stands which do not have these features. There is also evidence that more infected trees occurred on acid soils, i.e., pH 6, than on neutral or alkaline soils. Most severely infected stands were associated with soils characterized by a relatively thin humus layer.—D. E. Etheridge.

TABLE I

Altitude (ft. above sea level)	Frequencies					
	Site I		Site II		Site III	
	Obs.	Cal.	Obs.	Cal.	Obs.	Cal.
Below 4400	0	5.4	7	4.2	8	5.4
Above 4400	19	13.6	8	10.8	11	13.6
Totals	19	19	15	15	19	19

NOTE:—Total chi square=11.886, P=.01

TABLE II

Site factors having a positive influence on the rate of infection	Critical level	Sample basis	Contingency chi square[1]	Probability
Aspect	West, southwest	23	7.371	<.05
Aspect	W. SW. S	52	6.475	>.02
Altitude	Below 4400 ft	53	11.886	.01
Slope	< 14.5 per cent	53	14.173	.001
Soil texture	Light vs. heavy	53	0.132	Not sig.
Depth of humus (A_o)	< 1.75 ins	47	6.157	<.05 >.02
Soil nitrogen (total)	Over range 0.100% to 0.140%	53	0.043 to 2.240	Not sig.
Soil pH	< 5.95	53	6.420	< .05 > .02
Degree of windfall	Light vs. heavy	42	1.990	Not sig.
Site indexes:	Incidence of infs.			
I (dry)	0—20%	53	22.839	.001
II (Intermediate)	21—40%	53	"	"
III (Moist)	>—40%	53	"	"

[1] Degree of freedom=2, except for the site index item which is 4.

BRITISH COLUMBIA

A study of the Effect of Nematodes and Mites on Douglas-fir Beetle Flight.—The effect of nematodes and mites on the flight capacity and response to flight stimulation of the Douglas-fir beetle, *Denroctonus pseudotsugae* Hopk., was tested as a step in an investigation of the insect's flight behaviour. Two experiments were carried out, the first to determine the effect of mites and nematodes on response to flight stimulation and the second to determine their effect on the beetles' flight capacity. The insects used in the experiments were young adults collected within one day of emergence from logs overwintered near Lumby, B.C.

One hundred and twenty beetles were subjected to a flight stimulus, immediately after capture, by tossing each individual into the air in a room with one unshaded window. After each beetle had been tossed three times it was placed in one of four categories of response. Two responses, good and poor flight were considered positive, while the other two, fluttering and merely opening the elytra were considered negative.

Following the flight stimulation tests, each beetle was dissected to observe the gut condition (full or empty), sex, and the presence or absence of mites and internal and external nematodes. The results of this test are condensed in Table I.

To date, identifications indicate that there are at least seven species of nematodes, belonging to five genera, which are directly associated with the Douglas-fir beetle. Due to the complexity of the nematode larval stages, the lack of knowledge on their relation to the host, and the difficulty of identification, it has not been possible to determine which of these round worms is the most important. Because it was impractical to count any other than the adult stage due to occurrence of high numbers, relative expressions were used.

If the majority of these nematodes are true parasites, one would expect the internal species to be in the most favourable position to be a drain on the beetles' metabolic reserves and thus have the greatest effect on the beetles'

condition. However, it was noted that 12 of 87 beetles recorded as having good response had numerous internal nematodes and 13 of 22 beetles with a negative response had no internal nematodes.

The mites were external in all but two cases. Most were six-legged immature forms under the elytra.

In the second experiment, samples of beetles showing a strong flight response, as indicated by tossing, were attached to individual flight mills described by Chapman (Forest Biology Laboratory, Victoria, B.C., Interim Report. 1954). Thirty beetles were flown for a 4-hour period. As most of the beetles tended to fly intermittently the starting and stopping times were recorded and the flying time totalized. At the completion of the tests each individual was dissected and observations made as in the first experiment. Only four beetles had mites so their effect was disregarded.

Student's "t" test was used to compare the mean flying times of the uninfested males and females, and showed no significant difference. The mean flying time of all uninfested beetles was then used as a basis for comparison of the various degrees of infestation (internal nematodes only, external nematodes only, both internal and external nematodes, and internal nematodes regardless of infestation by external forms). There was no significant difference in any of the comparisons. The means, degrees of freedom and "t" values are given in Table II.

TABLE I

FLIGHT RESPONSE AND DISSECTION RESULTS OF 120 DOUGLAS-FIR BEETLES

Response	Total	Gut condition		Sex		No. Parasites	Nematodes			Mites only	Mites and Nematodes
		Full	Empty	Male	Female		Internal only	External only	Internal and External		
Positive	98	7	91	30	68	6	1	20	23	6	54
Negative	22	3	19	8	14	0	1	4	7	2	14
Total	120	10	110	38	82	6	2	24	30	8	68

TABLE II

ANALYSIS OF TOTAL FLYING TIMES IN 4-HOUR PERIOD OF 30 DOUGLAS-FIR BEETLES WITH VARIOUS DEGREES OF INFESTATION

Comparison and infestation	Mean flying time	d.f.	"t"
Uninfested males	156.7 min.		
vs.			
Uninfested females	147.4 "	7	.0016
Total uninfested vs.	152 min.		
1 External nematodes only	152 "	17	.0000
2 Internal nematodes only	148 "	13	.0913
3 Internal and external nematodes	181 "	12	.9500
4 Internal nematodes*	163 "	28	.4570

* Any beetles with internal nematodes regardless of external forms.

The first test indicates that the presence of mites and nematodes has no significant effect on the flight response of the insect immediately following emergence. The second test indicates the nematodes do not affect flight duration at this time.—M. D. Atkins.

Dieback of Douglas Fir.—Damage to the leaders and laterals on reproduction and sapling-sized (under 35 feet tall) Douglas fir (*Pseudotsuga menziesii* (Mirb.) Franco) was noted in the spring of 1956. An examination of young stands in widely separated regions showed the damage to be general and restricted to Douglas fir. Although light damage, under 1 to 2 per cent incidence of dead leaders, was found in most areas, moderate damage was noted near Salmon River in both natural regeneration and plantations, and severe damage near Sooke in natural regeneration. Sample plot analysis showed that dead leaders averaged 22 per cent and 52 per cent in damaged areas at Salmon River and Sooke respectively. Both areas of concentrated damage were on exposed dry slopes underlain with deep gravel which lacked ground water during the growing season. Despite this dryness Douglas fir was making good height growth. In the other areas examined the disorder appeared to occur on a random basis and was not correlated with exposure, elevation, or aspect. Frequently those areas with the best height growth had dieback damage.

A severe cold period, with dry air and strong winds which began on November 11, 1955, suddenly terminating a previous moist mild period, is believed to have caused the damage noted.

The dieback was evidenced by a yellowing, reddening, and then a thinning or loss of needles, followed by cracking of the bark and dying of the 1955 leader or top laterals. In the fall of 1956 there was extensive callusing and bark splitting at the juncture of the killed and healthy tissue. Side branches at and between whorls were observed to turn yellow and die. At Sooke, in addition to the above damage and frequently on the same trees, although not necessarily associated with the same fungi, there were trunk cankers at the juncture of branch and trunk. These cankers enlarged throughout the summer to girdle the bark, and killed the distal portion of the tree. Resinosis was generally absent except where the Douglas-fir bark beetle (*Dendroctonus pseudotsugae* Hopk.) was active.

Progressive dying in successively older branch whorls was observed at Sooke as the fungi which entered through the weakened or dead tops moved down the sapwood of the trunk. Some trees with this type of infection have already died. Trees have also been killed by trunk cankers. Resin soaking observed in the new springwood has not halted the lateral spread of fungi in the trunk. Where the tip of a leader is killed, and one lateral shows dominance, the spike of dead sapwood provides an entrance court for decay-producing fungi.

The most frequently isolated fungi from damaged leaders have been *Pullularia* sp., and *Phomopsis* sp. From the trunk cankers, *Dasyscyphus* sp., and *Stereum sanguinolentum* (Alb. & Schw. ex Fr.) Fr. have been isolated. These fungi have all been recorded previously as weakly parasitic under conditions of host injury or weakening. Inoculations are in progress in both field and greenhouse to test the pathogenicity of these fungi. Douglas-fir seedlings weakened by cold and by drought as well as healthy plants have been inoculated.

The possibility that those trees which flush earliest in the spring may be the last to harden in the fall and may be more susceptible to early frost than adjacent late-flushing trees is being investigated.

While leader diebacks have in the past caused only limited damage, it is noteworthy that following unusually low temperatures in 1955, extensive damage and mortality have been observed in localized areas. Genetic differences between individual trees would contribute in part to the random distribution of this damage. While this damage cannot be specifically related to the cold period, it probably results from it. The effect of this environmental condition on both the host and on the normal fungi of the area remains unknown.—W. A. Porter.

The Spruce Budworm Infestation in the Lillooet and Fraser River Areas.—The spruce budworm infestation in the Lillooet and Fraser River areas was first reported in 1953, and has been under close observation since 1954. The principal host is Douglas fir. In 1954 the outbreak was restricted to the Lillooet River and Lake area, and a smaller area in the Nahatlatch-Fraser river valleys (G. T. Silver and M. G. Thomson, Bi-Mon. Progr. Rept. 10(5): 2-3. 1954). The infestation has increased in size, and in 1957 extended along the Lillooet River and Lake, westward as far as Tisdall, northeast from Pemberton to D'Arcy, along the Anderson and Seton lakes to Lillooet and down the west side of the Fraser River Valley as far as Askom Mountain. The area of the outbreak in 1957 was calculated at 498 square miles compared with 452 square miles in 1956 and 379 square miles in 1955. The area for 1957 does not include the Anderson or Nahatlatch River valleys where the outbreak has subsided, nor a small area near Pavilion Mountain where spruce budworm populations increased considerably this year but defoliation was too light to map.

In 1955, stands along the Lillooet River suffered heavy defoliation and shoot damage. Some trees had all their buds killed the previous year, and new growth was restricted to adventitious buds. A good growing season in 1956, along with reduced defoliation, resulted in a general improvement in stand conditions. In 1957 defoliation of current foliage along the lower Lillooet River was 64 per cent and total defoliation now stands at 58 per cent. Stands in the vicinity of Pemberton, which had been damaged heavily in 1954 and 1955, suffered little or no defoliation in 1957. Consequently, many trees which had been expected to die are recovering, and many tree tops which had been completely stripped are putting out new growth. Top kill and probably scattered tree mortality may occur throughout portions of the outbreak area, but the general stand condition is good.

Defoliation along Anderson and Seton lakes was heavy in 1956 and 1957, but back feeding has not been severe and shoot mortality is light. These stands are in relatively good condition and have not suffered damage to the same extent that the recovering trees around Pemberton sustained in 1954 and 1955.

The infestation in the Nahatlatch River Valley has subsided and defoliation was relatively light in the Anderson River Valley in 1957.

The percentage of egg masses containing parasites remained low throughout the outbreak. Pupal parasitism varied from 35 to 60 per cent and larval mortality due to parasites was light to medium. No virus disease of any consequence has been encountered in any area.

The spruce budworm population, as indicated by egg counts, has decreased steadily in the Lillooet River and Lake area (Table I). The figures shown are averages and the range is large, i.e., 0 to 151 egg masses per 100 square feet of foliage surface in 1957. Egg populations in the other areas never reached the large numbers obtained in the older portion of the outbreak. There was an average decrease of about 60 per cent in the egg population in all areas in 1957 compared with 1956.

TABLE I

AVERAGE NUMBER OF SPRUCE BUDWORM EGG MASSES PER 100 SQUARE FEET OF FOLIAGE SURFACE

Area	1954	1955	1956	1957
Lillooet River and Lake	221	112	64	31
Tisdall—Nairn Falls	....	....	75	15
Pemberton to D'Arcy	....	39	46	20
Anderson and Seton Lakes	....	....	157	41
Fraser River	....	....	99	21
Nahatlatch—Anderson River valleys	....	....	30	9

The spruce budworm population is expected to continue its downward trend. There are still localized pockets in which the egg population is sufficiently high to cause heavy defoliation in 1958, but these represent only a small proportion of the total area.—G. T. Silver.

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